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Vocalizations and Display in the Long-tailed Ground-roller (*Uratelornis chimaera*)

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ABSTRACT.—During three field seasons in southwestern Madagascar we made opportunistic observations and tape recordings of the sounds produced by the Long-tailed Ground-roller (*Uratelornis chimaera*; Brachypteraciidae). Here we present new information on vocal behavior in this species and provide the first documentation of display and nonvocal production of sound by any ground-roller. *Received 17 June 2002, accepted 4 December 2002.*

The ground-rollers (Brachypteraciidae) are socially monogamous, sexually monomorphic, terrestrial, insectivorous birds endemic to Madagascar. Four species inhabit the humid forests of the east, while the Long-tailed Ground-roller (*Uratelornis chimaera*) is endemic to the semi-arid deciduous forests of the southwest (Langrand 2001). All five ground-rollers are highly secretive, such that little is known about their secondary vocalizations and courtship behavior (Langrand 2001). With this in mind, we studied Long-tailed Ground-rollers, collecting data on their vocal repertoire and displays.

During three seasons (September to February, 1997–2000) at Pointe Kilometre 32, north of Toliara in southwestern Madagascar (23° 05′ S, 43° 37′ E; see Seddon et al. 2000 for habitat description) we encountered at least seven different pairs of Long-tailed Ground-rollers. Using a Sennheiser ME67 directional microphone and a WM-D6C Sony Walkman we opportunistically recorded any sounds produced by these birds. From the resulting 70 min of recordings we identified four distinct vocalization types, the temporal and frequency characteristics of which are summarized in Table 1.

One vocalization (the "song") consisted of low-pitched, clipped, and emphatic hooting notes at 1,200–1,400 Hz, with 1–2 harmonics (Fig. 1a), usually delivered in an evenly spaced series (often 8–9 notes, but sometimes as few as 3 or as many as 12; Fig. 2a). Bouts of hooting were given from a concealed perch 2–6 m above the ground, with the vocalizing bird pumping its tail downward slightly in time with each hoot. We recorded bouts at dawn (05:30 to 06:15; GMT +04:00) and at dusk (18:40 to 19:15) lasting up to 20 min. The crepuscular (or nocturnal) timing of these bouts, and the fact that they carry far (audible to human ears for up to 200 m), suggests that they function in mate attraction and/or territory defense (see Catchpole and Slater 1985). Hooting appeared to be performed by only one bird per pair, presumably the male.

A second vocalization given by both sexes consisted of abrupt popping notes, given in couplets, the second note of higher frequency than the first, and often with a single harmonic. This call, previously transcribed as "too-tuc too-tuc too-tuc" (Langrand 2001), is herein referred to as the *tu-tuc* call (Fig. 1b). It was audible over only relatively short distances, and seemed to be given more frequently when pair members were within 10 m of each other.

A third call was a soft muffled *boo* (Fig. 1c), usually given in a series of 2–6, sometimes preceded, followed, or interrupted by *tu-tuc* calls (Fig. 2b). As with *tu-tuc* calls, *boos* were given most frequently on the ground or on low branches ≤2 m high.

A fourth vocalization (Fig. 1d) consisted of a disyllable that was louder, more drawn out, and more emphatic than the *tu-tuc* call, with a higher fundamental frequency for both notes (Table 1), and a more grating tone resulting in a stack of 4–10 harmonics up to about 12 kHz (mean number of harmonics = 5.7 ± 1.2 SD,

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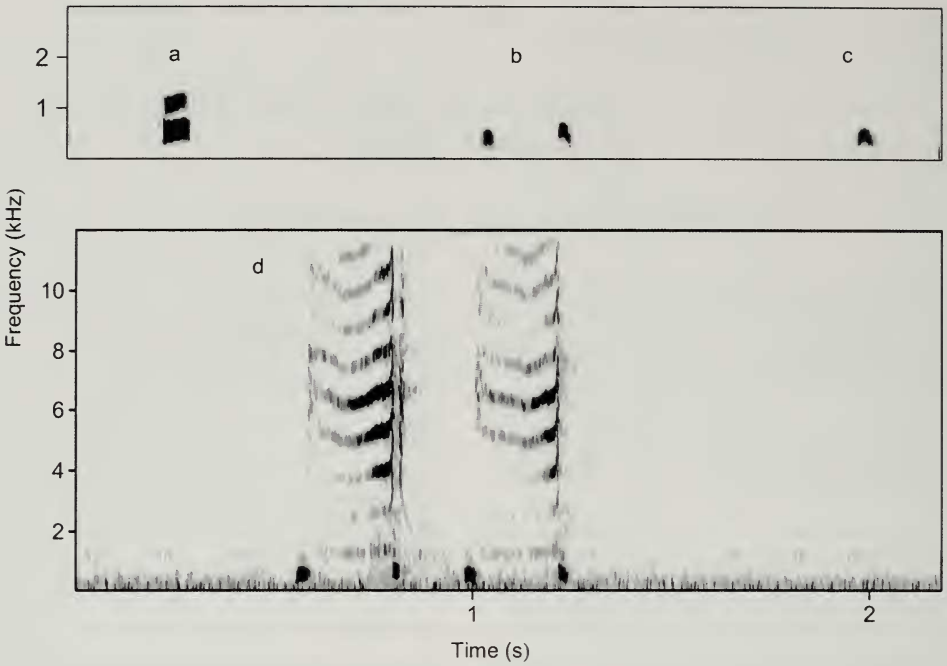

FIG. 1. Composite audio spectrogram of Long-tailed Ground-roller vocalizations: (a) one hoot given by a male (these are always given in series), (b) one *tu-tuc* call, (c) one *boo* call, and (d) one alarm call. All recordings were made by J. A. Tobias in the vicinity of nest holes at Pointe Kilometre 32, north of Toliara, Madagascar, November 2000 to January 2001. Recordings were digitized with a 16-bit acquisition card at a sampling rate of 16,000 Hz. Using the software Avisoft SASLabPro ver. 4.0c, calls were filtered to prevent aliasing and to remove background noise, and spectrograms were generated with the following settings: FFT = 512, bandwidth = 235 Hz, frequency resolution = 31 Hz, frame = 50%, window = FlatTop, overlap = 88%.

n = 17 calls). We refer to this as the "alarm call," as in all cases it was given by adults of both sexes standing alertly or nervously <5 m from a nest burrow.

In January 2001, we observed one Long-tailed Ground-roller in the nest-digging phase of the breeding cycle performing an unusual display involving the repeated nonvocal production of sound. The display was always preceded by a series of *tu-tuc* calls given from the ground, sometimes for several minutes, while the bird halted beneath a low (1–2 m high) branch, tilting its bill so that it pointed almost vertically upward. While standing motionless in this position the bird gradually increased the rate of *tu-tuc* calling to a crescen-

TABLE 1. Temporal and frequency characteristics of Long-tailed Ground-roller vocalizations. Means ± SD are given; different bouts were separated by ≥30 s of silence; syllables are evenly spaced notes wherein internote interval is at least half intersyllable interval. Measurements were taken from spectrograms that were generated from digitized recordings using Avisoft, at the settings listed in Fig. 1. All recordings were made by J. A. Tobias at Pointe Kilometre 32, north of Toliara, Madagascar, November 2000 to January 2001.

	Hoots	*Tu-tucs*	*Boos*	Alarms
Duration of syllable (s)	4.0 ± 1.3	0.27 ± 0.04	0.21 ± 0.07	0.28 ± 0.02
Number of notes per syllable	8.9 ± 2.8	2.0 ± 0.0	2.0 ± 0.5	2.0 ± 0.0
Rate (syllables/min)	3.4 ± 1.0	126 ± 25	8.5 ± 3.4	46.0 ± 2.8
Fundamental frequency (Hz)	305 ± 44	110 ± 2	93 ± 24	253 ± 88
Band width (Hz)	536 ± 82	602 ± 62	504 ± 49	10,600 ± 634
n (syllables, bouts)	18, 10	18, 8	10, 5	17, 2

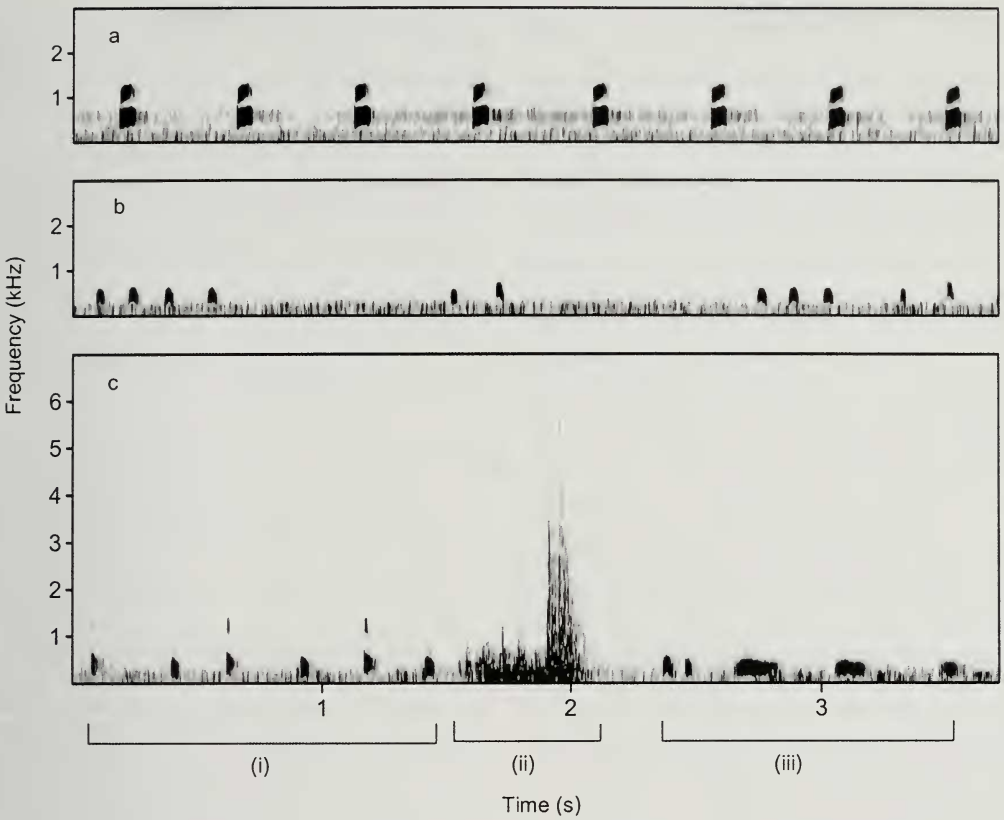

FIG. 2. Audio spectrograms of typical sequences of Long-tailed Ground-roller vocalizations: (a) a song consisting of a series of eight hoots; (b) a sequence of four *boo* calls, a *tu-tuc* call, three more *boos,* and a final *tu-tuc*; and (c) a display sequence consisting of (i) an introductory vocal phrase (a series of three *tu-tuc* calls), (ii) a nonvocal phase (fluttering and then "cracking" wing feathers as bird flies to perch), and (iii) a terminal vocal phrase (a short slightly descending series of *boo* call notes). All recordings were made by J. A. Tobias in the vicinity of nest holes at Pointe Kilometre 32, north of Toliara, Madagascar, November 2000 to January 2001. Spectrograms were produced as in Fig. 1.

do. The terminal phase of this crescendo formed a distinct introductory phase to the display: an accelerating burst of 3–10 *tu-tuc* calls (mean number of calls = 7.1 ± 2.7 SD; mean duration of series = 3.6 s ± 1.8 SD, n = 8 displays) which culminated in a loud ripping and cracking sound as the bird flew steeply up to the branch. This sound obviously was not produced vocally; the ripping always corresponded to the series of rapid wingbeats as the bird ascended to the perch, and the final loud cracking note was simultaneous with the last wingbeat before landing. This sudden and dramatic sound was followed by another vocal phase, a brief series of 3–6 soft *boo* notes lasting for a mean of 1.3 s ± 0.3 SD, the first notes brief and the last more protracted. After perching silently on the branch for 10–120 s, the bird usually dropped back to the ground and repeated the process almost exactly.

Langrand (2001) mentioned a harsh scratching note that sometimes terminated a series of *tu-tuc* calls, but while this undoubtedly refers to the sound described above, he neither mentioned the display nor suggested that the sound was produced nonvocally. Whether the wing tips were struck together to make this sound, or whether it was produced by a whiplash action, was impossible to determine, although the latter case seemed more likely. An audio spectrogram of the display sequence (Fig. 2c) begins with the crescendo in *tu-tuc* calling (i), followed by the nonvocal phase (ii), and finally the short series of *boo*

notes (iii). It also reveals that the nonvocal section (ii) contains six pulses of sound corresponding to the wingbeats; the first five (the ripping sound) are fairly muted and the final one (the "crack") is loud and has a broad bandwidth (mean = 7,542 Hz ± 423 SD).

One male performed this display a total of 20 times during a 50-min period (10:20–11: 10) on 7 January 2001, and three times during 5 min of a prolonged bout of hooting (i.e., singing) four days later. During the first observation period, we broadcast a recording of the display sound through a loudspeaker from a distance of 5 m. The male responded to this by approaching to <2 m from the speaker and increasing his performance rate from 7 displays/20 min to 12 displays/20 min. Throughout both observation periods, the displaying bird was 1–10 m from another individual, which we presumed to be the female due to its smaller size, narrower chest band, and shorter tail (Langrand 2001). On one occasion we saw this probable female perform a very similar display which was quieter in both vocal and nonvocal phases shortly after playback of the display sound. No direct interaction between the two birds was noted.

While the hooting song and alarm call have been reported previously in this species (Langrand 2001), no mention has been made of this highly stereotyped display. Furthermore, this is the first description of a nonvocal sound, or indeed any display produced by this species or any other member of the Brachypteraciidae. "Wing cracking" is a relatively rare phenomenon; it occurs in at least one other coraciiform family, the todies (Todidae; Kepler 2001), as well as a variety of unrelated families such as nightjars (Caprimulgidae; Cleere 1999) and manakins (Pipridae; Prum 1998, Bostwick 2000a). In manakins, nonvocal sounds function in courtship (Bostwick 2000b), and the same is likely in the Long-tailed Ground-roller (although participation by a presumed female is odd). Whether the other reclusive members of the Brachypteraciidae have similar displays remains to be discovered.

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